Leveraging Combat Casualty Care Solutions Today

MAJ Robert M. Wildzunas

The rapid growth in the size and number of urban centers, particularly in regions of political instability, means that the Army will increasingly conduct operations in urban areas, as evidenced by the ongoing hostilities in Iraq. This environment requires the Army to transform its doctrine, weapons and technology to ensure peace, as well as to transform its medical support to save Soldiers' and civilians' lives.

Patients are transported by helicopter from the 86th Combat Support Hospital, Baghdad, Iraq, Feb. 10, 2005. Several technology solutions are being examined to collect data on injuries, treatment and the equipment that was worn from point of injury through Level III and IV treatments. (U.S. Air Force photo by MSGT Dave Ahlschwede, Green Zone, Baghdad, Iraq.)

Battlefield wounds come in many shapes, sizes and degrees of severity. Medical personnel must train for and expect to treat casualties as a result of:

- Direct fire and fragmentation injuries, including injuries from small arms and armored vehicles, rocket-propelled grenades, improvised explosive devices and ricochets.
- Indirect fire from mines, artillery, rockets, mortars and Scud missiles.
- Blasts, flame weapons and incendiary devices.
- Crushing injuries, falls from heights and injuries from falling debris, concrete, glass, heavy wood and metal.

Medical personnel will also need to be prepared for increases in injuries resulting from such diverse threats as:

- Suicide bombers.
- Ground vehicle and helicopter accidents.

SPC Michael P. Gustetic, a military policeman with the Multinational Force-Iraq, takes instructions as he gives an intravenous injection during the combat lifesaver course at the Camp Victory Troop Medical Clinic in Iraq, March 17, 2005. (U.S. Army photo by SPC Mary Rose.)

- Non-life-threatening injuries from incidental contact with civilians.
- Blunt trauma from nonbattle injuries and other noncombatant injuries.

COL Kevin V. Wilkerson, Director, Infantry Futures, has articulated several challenges specifically directed toward the U.S. Army Medical Research and Materiel Command's (MRMC's) Combat Casualty Care Research Program (CCCRP). From the infantry warfighter's perspective, combat medics need:

- Strategies for ground, air and mounted Soldiers to be better trained and equipped to be first responders.
- An enhanced first-aid kit for first responders.
- A warfighter physiological status monitoring system.
- Better hydration, pulse and respiration management such as wristwatch monitors and silent vibration alarms.
- Hand-held or man-portable systems that allow medics on the ground to query competent medical professionals to assist in casualty triage.
- The capability to extract wounded Soldiers while under fire.
- Clotting agents that have a longer shelf life and can be carried by the field medic.
- Blood substitutes to replace or sustain casualties until they can receive transfusions.
- The ability to conduct data collection of injuries, treatment and equipment worn from point of injury through Level III and IV treatments.
- Biomedical mapping of the body, including extremities, for use in designing protective equipment.

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MRMC is leveraging technological advances in casualty care to ensure that research solutions get into the lifesavers' hands today and to provide medical teams with the best technologies available to reduce battlefield trauma and casualties. Combat casualty care researchers are evolving ideas from the laboratory bench to products that can save lives on the battlefield.

Training and Equipping First Responders

The Army has three levels of training for combat medical treatment. All Soldiers receive training in fundamental first-aid skills. Combat lifesavers are trained in advanced first aid with 3 days of instruction and yearly skills validation. Combat medics (91W) are similar to civilian emergency medical technicians. They receive 16 weeks of training, including clinicals and field training exercises, sustainment training and twice-yearly skills validation.

MRMC researchers envision that many products used today by medics will eventually be pushed forward to combat lifesavers and individual Soldiers on the forward battlefield. The MRMC CCCRP focuses on enabling medics with technology currently in the hands of only physicians and nurses. Farther out on the technology horizon, the Defense Advanced Research Projects Agency's (DARPA's) Soldier Self-Care program may represent the next revolution in tactical combat casualty care. DARPA's goal is to develop technologies that allow warfighters to administer self-aid for minor to moderate injuries, thereby significantly reducing the requirements

Run on a hand-held PDA, the BMIS-T helps gather information as part of a semiautomated trauma triage capability that will provide critical casualty information remotely and continuously to battlefield medics. (U.S. Army photo by Larry Sorcher.)

for medic support and/or evacuation. Advances in military medical technology will provide individual Soldiers, combat lifesavers and combat medics with the ability to reduce hemorrhage, control pain and stabilize injuries for further treatment by medical staff.

The new Individual First-Aid Kit (IFAK) will increase the abilities of individual Soldiers and combat lifesavers to perform more of the lifesaving and treatment functions that only medics are able to do today. Weighing only 1.08 pounds and measuring 1.28 cubic inches, the IFAK includes these expendable items:

- A roll of 4-inch gauze.
- A roll of 2-inch tape.
- Four latex exam gloves.
- A nasopharyngeal airway.
- An Israeli pressure dressing.
- A combat application tourniquet.
- A lightweight pouch.

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The IFAK is being considered as an item that will be issued to every Soldier through the Soldier-as-a-System Rapid Fielding Initiative. The Army Medical Department has also developed the improved Combat Medic Vest System (CMVS) that has 40 percent of the surgical instruments and supply sets in the vest to free the medic's hands for treating Soldiers. The CMVS has completed testing and is in production.

Warfighter Physiological Status Monitoring (WPSM)

The WPSM system of wearable physiological sensors will provide physiologic data useful to Soldiers, medics and commanders. Specific WPSM system capabilities targeted include monitoring of core and skin temperature, water intake, heart rate and ventilation and the metabolic demands of marching and sleep (activity/inactivity). A new sensor system capable of detecting ballistic impact and vital life signs will be integrated into the WPSM to permit the combat medic to remotely identify wounded Soldiers.

Additional refinements will include algorithms and predictive models to meet requirements for remote triage using the ballistic impact detection system and life-sign detection system, plus blood pressure, respiratory function and neurological status. Additionally, force health protection monitoring — including thermal stress risks, hydration state, sleep status, mental alertness status, metabolic status/energy reserve and altitude adaptation — will be integrated into the WPSM. Long-term WPSM plans include chemical and biological agent exposure monitoring as well.

Remote Triage and Casualty Evacuation

During the Vietnam War, the killed-in-action (KIA) rate was twice as high for combat medics as for infantrymen. As many as 25 percent of the medics who were KIA died attempting to reach a casualty who was not saveable. The contemporary urban battlefield is even more lethal to warfighters and medics. Several future products under development will remotely identify and triage injured Soldiers and remove them from lines of fire.

A Soldier with the 2nd Battalion, 6th Infantry Regiment, renders aid for a simulated gunshot wound during urban combat training in Baghdad, Iraq. (U.S. Army photo by SGT Vernon Freeman. Used with permission from the U.S. Army Medical Command.)

In addition to WPSM-generated information, microimpulse radar (MIR) technology will enable medics to monitor respiratory rate and heart rate through clothing, chemical and biological protection equipment and body armor. A computer-assisted acoustic sensor system will help identify a pneumothorax (PX). Both PX and MIR vital sign detectors can be integrated into a hand-held personal digital assistant (PDA) application — the Battlefield Medical Information System-Telemedicine (BMIS-T). Information gathered from these physiological signals will help develop a semiautomated trauma triage capability that will provide critical casualty information remotely and continuously to battlefield medics.

Advances in robotics, artificial intelligence and navigation software/hardware will also assist military first responders, especially in reducing or eliminating first responders' exposure to fire, chemical or radiation contamination, gunfire and weapons of mass destruction. Likewise, robotic and telerobotic surgical capabilities may save the lives and limbs of combat Soldiers and civilian emergency personnel by enabling more rapid surgical attention to casualties — even at the injury scene.

Although no formal requirements currently exist for such medical robotics or unmanned systems, the DOD Joint Robotics Program chartered the Family of Integrated Rapid Response Equipment Integrated Product Team (IPT) in 2004. The IPT's first designated goal was to design a system that includes casualty location, assessment, extraction, treatment and evacuation. DARPA and the MRMC Telemedicine and Advanced Technology Research Center have initiated several research and development programs to investigate these concepts.

Clotting Agents and Blood Substitutes

Acute hemorrhage remains the leading cause of battlefield deaths. The CCCRP has had several successes with improved hemostatic products such as a dry fibrin sealant dressing, a Chitosan Bandage and IV injectable clotting agents such as rFVIIa. However, the optimal fluid and resuscitation strategy remains unknown. MRMC is investigating component products derived from whole blood. The components selected must be as effective as blood, available for all levels of fluid resuscitation, stable for long periods of time at ambient combat conditions and have no requirement for matching or typing.

Once MRMC scientists identify the critical blood components, they will partner with commercial entities to provide component therapies and clotting agents that can be carried by field medics. One promising candidate,

SFC Ralph E. Hurley II (left), First Army Command Surgeons Office, supervises as Navy Gas Turbine Mechanic Jonathan W. Cummins practices IV insertion during combat lifesaver training, Williamsburg, VA, Jan. 17, 2005. (Photo courtesy of First Army Public Affairs.)

A fourth-year student at the Uniformed Services University of the Health Sciences treats a simulated casualty during *Operation Bushmaster,* Camp Bullis, TX. Students from the Army, Navy and Air Force applied clinical and tactical skills during the 72-hour training exercise. (U.S. Navy photo by SN Kory Kepner.)

freeze-dried (powdered) plasma, offers potential as a volume expander to sustain a casualty to definitive care. It helps resuscitated patients to clot better, has nearly 100 percent of fresh plasma's clotting factors, replaces frozen plasma, and has a shelf life of up to 1 year.

MRMC is also investigating a rapid sterilization system that will use whole blood from volunteers and prepare it for donation to a patient within a few hours, making blood available anywhere on the battlefield. Pending successful clinical trials that demonstrate safety and efficacy, blood substitutes are another very attractive option under consideration that offer the potential of providing both volume resuscitation and oxygen delivery.

Trauma Data Collection, Registry and Biomedical Mapping

Several technology solutions — from electronic storage devices (ESDs) such as "thumb drives" to personal information carriers (PICs) and the BMIS-T — are being examined to collect data on injuries, treatment and the equipment that was worn from point of injury through Level III and IV treatments. The PIC and ESDs allow a Soldier's medical record and treatment history to be downloaded anywhere on the battlefield. The ESDs must be:

- Compatible with all types of computer hardware.
- Capable of securely storing text, voice, video and digital data.
- Designed to allow the system to evolve with technology.
- Able to run on a wireless, hand-held PDA.

The BMIS-T will ultimately evolve into a medical diagnostic device that will enable first responders and other healthcare staff to quickly and accurately capture, integrate, transmit and display data from medical histories/physical examinations, medical reference libraries, diagnostic and treatment decision aids, medical sustainment training and medical mission planning.

Regardless of the source, de-identified field records are being abstracted, coded and entered into a theater trauma data registry. MRMC generates monthly reports on epidemiologic analysis of body area, nature of injury and causative agent. Information is intended for use as feedback within the theater treatment facilities to monitor injuries. Outside the theater, the information has utility for combat epidemiology, materiel developers' design of wearable protective devices, medical response systems, capabilities and staffing. Future refinements include hyperaccurate digital coordinate data obtained from computed tomography images for all penetrating injuries. Materiel developers will then be able to use these digital coordinates for designing new equipment based on frequency and maps of injury severity.

Future battles in complex, urban terrain will continue to involve highly mobile forces, highly lethal weaponry, violent close combat, continuous maneuver and decentralized battle command. As the enemy adapts to U.S. operations and tactics, U.S. forces will have to counteradapt, and future warfare will surely increase to a level of fluidity and lethality previously unknown. Medical forces must keep up with supported combat units and prepare now to anticipate implicit future battlefield challenges. Close coordination with warfighters and an understanding of their medical challenges must be an institutional priority for MRMC as medical researchers continue to support the warfighters' efforts by leveraging combat casualty care solutions today.

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